tion, BEST_LAT, BEST_LON, BEST_SPEED, and BEST_DIRECTION.

Applications

There are a variety of commercially valuable applications of the inventive technology disclosed herein. For example, in addition to the basic function of tracking the location of a mobile cellular telephone, the present invention may be employed to offer subscribers billing rates that vary on the basis of the location from which a call was made. As depicted in FIG. 9, a location tape, containing a record over time of the locations of the subscribers' cellular telephones, may be merged with a billing tape to produce a modified billing tape. The billing tape contains data indicating the cost for each telephone call made by the cellular telephones within a certain time period. This cost is based upon one or more predetermined billing rates. The modified billing data is based upon a different rate for calls made from certain specified locations. For example, the system may apply a lower billing rate for telephone calls made from a user's home or office.

The invention may also be employed to provide emergency assistance, for example, in response to a "911" call. In this application, the location system includes means for automatically sending location information to a specified receiving station in response to receiving a "911" signal from a cellular telephone.

Further, the invention may be employed in connection with an alarm service. In this application, a means is provided for comparing the current location of a given telephone with a specified range of locations and indicating an alarm condition when the current location is not within the prescribed range.

Yet another application involves detecting a lack of signal transmissions by a given telephone and in response thereto automatically paging the telephone to cause it to initiate a signal transmission. This allows the system to locate a telephone that has failed to register itself with the cellular system. Such a feature could be used, for example, to generate an alarm for subscribers at remote locations.

Still another application involves estimating a time of arrival of a given telephone at a specified location. This application is useful, for example, in connection with a public transportation system to provide estimated times of arrival of busses along established routes. Many other applications of this feature are also possible.

Conclusion

Finally, the true scope the present invention is not limited to the presently preferred embodiments disclosed herein. For example, it is not necessary that all or even any of the "cell site systems" be collocated with actual cell sites of an associated cellular telephone system. Moreover, communication links other than T1 links may be employed to couple the cell site systems to the central site system. In addition, the timing signal receiver need not be a GPS receiver, as other means for providing a common timing signal to all cell site systems will be apparent to those skilled in the art. Furthermore, the present invention may be employed in connection with many applications not specifically mentioned above. These include stolen vehicle recovery, fleet management, cell system diagnostics, and highway management. Accordingly, except as they may be expressly so limited, the scope of protection of the following claims is not intended to be limited to the particularities described above.

We claim:

1. A cellular telephone location system for determining the locations of multiple mobile cellular telephones each initiating periodic signal transmission over one of a prescribed set of reverse control channels, comprising:

(a) at least three cell site systems, each cell site system comprising: an elevated ground-based antenna; a baseband convertor operatively coupled to said antenna for receiving cellular telephone signals transmitted over a reverse control channel by said cellular telephones and providing baseband signals derived from the cellular telephone signals; a timing signal receiver for receiving a timing signal common to all cell sites; and a sampling subsystem operatively coupled to said timing signal receiver and said baseband convertor for sampling said baseband signal at a prescribed sampling frequency and formatting the sample signal into frames of digital data, each frame comprising a prescribed number of data bits and time stamp bits, said time stamp bits representing the time at which said cellular telephone signals were received; and

(b) a central site system operatively coupled to said cell site systems, comprising: means for processing said frames of data from said cell site systems to generate a table identifying individual cellular telephone signals and the differences in times of arrival of said cellular telephone signals among said cell site systems; and means for determining, on the basis of said times of arrival differences, the locations of the cellular telephones responsible for said cellular telephone signals.

2. A cellular telephone location system as recited in claim 1, wherein said timing signal receiver comprises a global positioning system (GPS) receiver.

3. A cellular telephone location system as recited in claim 1, wherein said central site system comprises a correlator for cross-correlating the data bits of a frame from one cell site system with corresponding data bits from each other cell site system.

4. A cellular telephone location system as recited in claim 3, wherein said central site system further comprises:

a plurality of data inputs ports each connected to receive a signal from one of said cell site systems;

interface/deformatting circuits for receiving the signals from said input ports and outputting data bits and a clock signal;

a plurality of FIFO registers each coupled to an interface/deformatting circuit to receive the data bits and clock signal from that circuit;

a switch comprising a plurality of input ports, each input port coupled to an output of one of said FIFO registers, and a first output port (A) and a second output port (B), said first output port coupled to an input port of said correlator;

a computer operatively coupled to said switch to select two of the inputs to said switch to be output on the output ports of said switch;

a RAM control circuit coupled to said computer and said FIFO registers;

a sample read clock controlled by said computer and said RAM control to read sample bits from previously selected FIFO registers; and

a quadrature channel generator comprising an input port coupled to said second output port of said

switch and a first output port (B1) and a second output port (B2), and means for outputting an in-phase signal on said first output port (B1) and a quadrature signal on said second output port (B2);

wherein said correlator calculates a first correlation coefficient for said DATA A and DATA B1 signals, and a second correlation coefficient for said DATA A and DATA B2 signals.

5. A cellular telephone location system as recited in claim 1, wherein said baseband convertors each comprise: a first mixer providing an intermediate frequency (IF) signal; a synthesizer providing a local oscillator (LO) signal; a single sideband mixer operatively coupled to said first mixer and said synthesizer for converting said IF signal to an upper sideband signal and a lower sideband signal; and means for filtering said upper sideband and lower sideband signals and providing said baseband signals on the basis of the filtered upper and lower sideband signals.

6. A cellular telephone location system as recited in claim 1, comprising:

first receiver means at a first cell site for receiving a cellular telephone signal;

demodulator means at said first cell site for demodulating the received cellular telephone signal at said first cell site to produce a demodulated digital bit stream;

first modulator means at said first cell site for modulating the demodulated digital bit stream to reconstruct the cellular telephone signal as it was originally transmitted, whereby a first reconstructed cellular telephone signal is produced;

first cross-correlator means at said first cell site for cross-correlating said reconstructed signal against the cellular telephone signal received at said first cell site to produce a first peak indicative of a time of arrival of the cellular telephone signal at the first cell site;

means for determining the time of arrival of the cellular telephone signal at the first cell site on the basis of said first peak and producing first time of arrival data indicative thereof;

means for sending the demodulated digital bit stream and first time of arrival data from the first cell site to the central site;

means for distributing the demodulated digital bit stream and first time of arrival data to a second cell site;

second modulator means at said second cell site for modulating the demodulated digital bit stream at the second cell site to reconstruct the cellular telephone signal as it was first transmitted by the cellular telephone, whereby a second reconstructed cellular telephone signal is produced;

second receiver means at said second cell site for receiving said cellular telephone signal;

second cross-correlator means at said second cell site for cross-correlating the second reconstructed signal against the cellular telephone signal received at the second cell site to produce a second peak indicative of a time of arrival of the cellular telephone signal at the second cell site;

means for determining the time of arrival of the cellular telephone signal at the second cell site on the basis of said second peak and producing second time of arrival data indicative thereof;

means for sending said second time of arrival data from the second cell site to the central site; and

means at said central site for determining time difference of arrival data on the basis of said first and second time of arrival data.

7. A cellular telephone location system as recited in claim 1, comprising location estimation means for:

(1) creating a grid of theoretical points covering a prescribed geographic area, said theoretical points being spaced at prescribed increments of latitude and longitude;

(2) calculating theoretical values of time delay for a plurality of pairs of cell sites;

(3) calculating a least squares difference (LSD) value based on the theoretical time delays and measured time delays for a plurality of pairs of cell sites;

(4) searching the entire grid of theoretical points and determining the best theoretical latitude and longitude for which the value of LSD is minimized; and

(5) starting at the best theoretical latitude and longitude, performing another linearized-weighted-least-squares iteration to resolve the actual latitude and longitude to within a prescribed number of degrees or fraction of a degree.

8. A cellular telephone location system as recited in claim 7, wherein said calculating step (2) comprises accounting for any known site biases caused by mechanical, electrical, or environmental factors, said site biases determined by periodically calculating the positions of reference cellular transmitters at known locations.

9. A cellular telephone location system as recited in claim 7, wherein said least squares difference is given by:

$$LSD=[Q_{12}(Delay\_T_{12}-Delay\_O_{12})^2+Q_{13}(Delay\_T_{13}-Delay\_O_{13})^2+\ldots Q_{xy}(Delay\_T_{xy}-Delay\_O_{xy})^2]$$

where, Delay_T_{xy} represents the theoretical delay between cell sites x and y, x and y being indices representative of cell sites; Delay_O_{xy} represents the observed delay between cell sites x and y; Q_{xy} is the quality factor the delay measurement cell sites x and y, said quality factor being an estimated measure of the degree to which multipath or other anomalies may have affected a particular delay measurement.

10. A cellular telephone location system as recited in claim 7, further comprising means for detecting a first leading edge of a cellular telephone signal and rejecting subsequent leading edges of said cellular telephone signal, whereby the effects of multipath may be reduced.

11. A cellular telephone location system as recited in claim 1, comprising velocity estimation means for:

(1) creating a grid of theoretical points covering a prescribed range of velocities, said theoretical points being spaced at prescribed increments;

(2) calculating theoretical values of frequency difference for a plurality of pairs of cell sites;

(3) calculating a least squares difference (LSD) value based on the theoretical frequency differences and measured frequency differences for a plurality of pairs of cell sites;

(4) searching the entire grid of theoretical points and determining the best theoretical velocity for which the value of LSD is minimized; and

(5) starting at the best theoretical velocity, performing another linearized-weighted-least-squares iteration to resolve the actual velocity to within a prescribed tolerance.

12. A cellular telephone location system as recited in claim 1, further comprising a database for storing location data identifying the cellular telephones and their respective locations, and means for providing access to said database to subscribers at remote locations.

13. A cellular telephone location system as recited in claim 12, further comprising means for providing location data to a specific one of said cellular telephones upon request by the specific telephone.

14. A cellular telephone location system as recited in claim 12, further comprising means for merging said location data with billing data for said cellular telephones and generating modified billing data, wherein said billing data indicates the cost for each telephone call made by said cellular telephones within a certain time period, said cost being based upon one or more predetermined billing rates, and said modified billing data is based upon a different rate for calls made from one or more prescribed locations.

15. A cellular telephone location system as recited in claim 14, wherein the system applies a lower billing rate for telephone calls made from a user's home.

16. A cellular telephone location system as recited in claim 1, further comprising means for transmitting a signal to a selected cellular telephone to cause said selected telephone to transmit a signal over a control channel.

17. A cellular telephone location system as recited in claim 1, further comprising means for automatically sending location information to a prescribed receiving station in response to receiving a distress signal from a cellular telephone, whereby emergency assistance may be provided to a user in distress.

18. A cellular telephone location system as recited in claim 1, further comprising means for comparing the current location of a given telephone with a prescribed range of locations and indicating an alarm condition when said current location is not within said prescribed range.

19. A cellular telephone location system as recited in claim 1, further comprising means for detecting a lack of signal transmissions by a given telephone and in response thereto automatically paging said given telephone to cause said given telephone to initiate a signal transmission and means for indicating an alarm condition.

20. A cellular telephone location system as recited in claim 1, further comprising means for estimating a time of arrival of a given telephone at a prespecified location.

21. A cellular telephone location system as recited in claim 1, further comprising means for continuously tracking a given telephone by receiving voice signals transmitted by said given telephone over a voice channel and determining the location of said given telephone on the basis of said voice signals.

22. A ground-based cellular telephone system serving a plurality of subscribers possessing mobile cellular telephones, comprising:

(a) at least three cell sites equipped to receive signals sent by multiple mobile cellular telephones each initiating periodic signal transmissions over one of a prescribed set of reverse control channels;

(b) locating means for automatically determining the locations of said cellular telephones by receiving and processing signals emitted during said periodic reverse control channel transmissions; and

(c) database means for storing location data identifying the cellular telephones and their respective locations, and for providing access to said database to subscribers at remote locations.

23. A ground-based cellular telephone system as recited in claim 22, further comprising means for providing location data to a specific one of said cellular telephones upon request by the specific telephone.

24. A ground-based cellular telephone system as recited in claim 22, further comprising means for merging said location data with billing data for said cellular telephones and generating modified billing data, wherein said billing data indicates the cost for each telephone call made by said cellular telephones within a certain time period, said cost being based upon one or more predetermined billing rates, and said modified billing data is based upon a different rate for calls made from one or more prescribed locations.

25. A ground-based cellular telephone system as recited in claim 22, further comprising means for transmitting a signal to a selected cellular telephone to cause said selected telephone to transmit a signal over a control channel.

26. A ground-based cellular telephone system as recited in claim 22, further comprising means for automatically sending location information to a prescribed receiving station in response to receiving a distress signal from a cellular telephone, whereby emergency assistance may be provided to a subscriber in distress.

27. A ground-based cellular telephone system as recited in claim 22, further comprising means for comparing the current location of a given telephone with a prescribed range of locations and indicating an alarm condition when said current location is not within said prescribed range.

28. A ground-based cellular telephone system as recited in claim 22, further comprising means for detecting a lack of signal transmissions by a given telephone and in response thereto automatically paging said given telephone to cause said given telephone to initiate a signal transmission.

29. A ground-based cellular telephone system as recited in claim 22, further comprising means for estimating a time of arrival of a given telephone at a prespecified location.

30. A ground-based cellular telephone system as recited in claim 22, further comprising means for continuously tracking a given telephone by receiving voice signals transmitted by said given telephone over a voice channel and determining the location of said given telephone on the basis of said voice signals.

31. A method for determining the location(s) of one or more mobile cellular telephones periodically transmitting signals over one of a prescribed set of reverse control channels, comprising the steps of:

(a) receiving said reverse control channel signals at at least three geographically-separated cell sites;

(b) processing said signals at each cell site to produce frames of data, each frame comprising a prescribed number of data bits and time stamp bits, said time stamp bits representing the time at which said frames were produced at each cell site;

(c) processing said frames of data to identify individual cellular telephone signals and the differences in times of arrival of said cellular telephone signals among said cell sites; and

(d) determining, on the basis of said times of arrival differences, the locations of the cellular telephones responsible for said cellular telephone signals.

32. A method as recited in claim 31, further comprising the steps of storing, in a database, location data identifying the cellular telephones and their respective locations, and providing access to said database to subscribers at remote locations.

33. A method as recited in claim 31, further comprising merging said location data with billing data for said cellular telephones and generating modified billing data, wherein said billing data indicates the cost for each telephone call made by said cellular telephones within a certain time period, said cost being based upon one or more predetermined billing rates, and said modified billing data is based upon a different rate for calls made from one or more prescribed locations.

34. A method as recited in claim 31, further comprising transmitting a signal to a selected cellular telephone to cause said selected telephone to transmit a signal over a control channel.

35. A method as recited in claim 31, further comprising automatically sending location information to a prescribed receiving station in response to receiving a distress signal from a cellular telephone, whereby emergency assistance may be provided to a subscriber in distress.

36. A method as recited in claim 31, further comprising comparing the current location of a given telephone with a prescribed range of locations and indicating an alarm condition when said current location is not within said prescribed range.

37. A method as recited in claim 31, further comprising detecting a lack of signal transmissions by a given telephone and in response thereto automatically paging said given telephone to cause said given telephone to initiate a signal transmission.

38. A method as recited in claim 31, further comprising estimating a time of arrival of a given telephone at a prespecified location.

39. A method as recited in claim 31, further comprising continuously tracking a given telephone by receiving voice signals transmitted by said given telephone over a voice channel and determining the location of said given telephone on the basis of said voice signals.

40. A method as recited in claim 31, comprising the steps of:

receiving a cellular telephone signal at a first cell site;

demodulating the received cellular telephone signal at said first cell site to produce a demodulated digital bit stream;

modulating the demodulated digital bit stream to reconstruct the cellular telephone signal as it was originally transmitted, thereby producing a first reconstructed cellular telephone signal;

cross-correlating said reconstructed signal against the cellular telephone signal received at said first cell site to produce a first peak indicative of a time of arrival of the cellular telephone signal at the first cell site;

determining the time of arrival of the cellular telephone signal at the first cell site on the basis of said first peak and producing first time of arrival data indicative thereof;

sending the demodulated digital bit stream and first time of arrival data from the first cell site to a central site;

distributing the demodulated digital bit stream and first time of arrival data to a second cell site;

modulating the demodulated digital bit stream at the second cell site to reconstruct the cellular telephone signal as it was first transmitted by the cellular telephone, thereby producing a second reconstructed cellular telephone signal;

receiving said cellular telephone signal at said second cell site;

cross-correlating the second reconstructed signal against the cellular telephone signal received at the second cell site to produce a second peak indicative of a time of arrival of the cellular telephone signal at the second cell site;

determining the time of arrival of the cellular telephone signal at the second cell site on the basis of said second peak and producing second time of arrival data indicative thereof;

sending said second time of arrival data from the second cell site to the central site; and

determining time difference of arrival data on the basis of said first and second time of arrival data.

41. A method as recited in claim 31, comprising estimating the location of a cellular telephone by performing the following steps:

(1) creating a grid of theoretical points covering a prescribed geographic area, said theoretical points being spaced at prescribed increments of latitude and longitude;

(2) calculating theoretical values of time delay for a plurality of pairs of cell sites;

(3) calculating a least squares difference (LSD) value based on the theoretical time delays and measured time delays for a plurality of pairs of cell sites;

(4) searching the entire grid of theoretical points and determining the best theoretical latitude and longitude for which the value of LSD is minimized; and

(5) starting at the best theoretical latitude and longitude, performing another linearized-weighted-least-squares iteration to resolve the actual latitude and longitude to within a prescribed number of degrees or fraction of a degree.

42. A method as recited in claim 41, wherein said calculating step (2) comprises accounting for any known site biases caused by mechanical, electrical, or environmental factors, said site biases determined by periodically calculating the positions of reference cellular transmitters at known locations.

43. A method as recited in claim 41, wherein said least squares difference is given by:

$$LSD=[Q_{12}(Delay\_T_{12}-Delay\_O_{12})^2+Q_{13}\cdot(Delay\_T_{13}-Delay\_O_{13})^2+\ldots Q_{xy}(Delay\_T_{xy}-Delay\_O_{xy})^2]$$

where, $Delay\_T_{xy}$ represents the theoretical delay between cell sites x and y, x and y being indices representative of cell sites; $Delay\_O_{xy}$ is the observed delay between cell sites x and y; Q_{xy} is the quality factor the delay measurement cell sites x and y, said quality factor being an estimated measure of the degree to which multipath or other anomalies may have affected a particular delay measurement.

44. A method as recited in claim 40, further comprising detecting a first leading edge of a cellular telephone signal and rejecting subsequent leading edges of said cellular telephone signal.

45. A method as recited in claim 31, comprising estimating the velocity of a cellular telephone by performing the following steps:

(1) creating a grid of theoretical points covering a prescribed range of velocities, said theoretical points being spaced at prescribed increments;

(2) calculating theoretical values of frequency difference for a plurality of pairs of cell sites;

(3) calculating a least squares difference (LSD) value based on the theoretical frequency differences and measured frequency differences for a plurality of pairs of cell sites;

(4) searching the entire grid of theoretical points and determining the best theoretical velocity for which the value of LSD is minimized; and

(5) starting at the best theoretical velocity, performing another linearized-weighted-least-squares iteration to resolve the actual velocity to within a prescribed tolerance.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,327,144
DATED : July 5, 1994
INVENTOR(S) : Louis A. Stilp, et. al.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

Title page, item [75], Inventor: should read --Louis A. Stilp--.

Signed and Sealed this

Twelfth Day of March, 1996

Attest:

Bruce Lehman

BRUCE LEHMAN

Attesting Officer *Commissioner of Patents and Trademarks*

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

TRUEPOSITION, INC., PLAINTIFF/ COUNTERCLAIM- DEFENDANT,	)	
v.	)	CA NO. 05-00747-SLR
ANDREW CORPORATION, DEFENDANT/ COUNTERCLAIM-PLAINTIFF.	)	

EXPERT REPORT OF DR. DAVID GOODMAN
<u>ON THE INVALIDITY OF U.S. PATENT NO. 5,327,144</u>

EXHIBIT
300
1-16-07

I. INTRODUCTION

Andrew Corporation has retained me as a technical expert in this case. I expect to testify at trial regarding the matters set forth in this report if asked by the Court or the parties' attorneys. I will also be prepared to provide the Court and the jury with a tutorial on the technology involved in this matter, including the evolution of the technology. I am being compensated for my work associated with the litigation at my customary rate of $600 per hour. My compensation does not depend on the outcome of this litigation, the opinions I express, or my testimony.

I understand that TruePosition, Inc. has asserted certain claims of United States Patent 5,327,144 against Andrew Geometrix products. I submit this expert report, which contains my opinion regarding the invalidity of the claims of the '144 patent asserted by TruePosition. I have been asked to determine whether claims 1, 2, 22, 31, and 32, of the '144 patent are valid. For the reasons stated below, it is my opinion that the asserted claims are invalid because they are anticipated by Japanese Patent Application Kokai (Laid-Open) Publication No.: H3-239091, October 24, 1991 ("the Kono application").

II. BACKGROUND AND QUALIFICATIONS

A. QUALIFICATIONS

I am currently a Program Director at the National Science Foundation in Arlington, Virginia on temporary assignment from my position as a professor of Electrical and Computer Engineering at Polytechnic University in Brooklyn, New York. Before joining the NSF, I was Director of the Wireless Internet Center for Advanced Technology (WICAT), located at Polytechnic University, Columbia University, and the University of Virginia. WICAT is a National Science Foundation Industry/University Cooperative Research Center. From August 1999 until August 2001, I was Head of the Department of Electrical and Computer Engineering at Polytechnic University.

Before joining Polytechnic University in 1999, I was a Professor of Electrical and Computer Engineering at Rutgers, the State University of New Jersey. From 1988 until 1991, I was Chairman of the Department of Electrical and Computer Engineering at Rutgers. In 1989, I founded the Wireless Information Network Laboratory (WINLAB) at Rutgers University.

WINLAB was the first center of excellence at a United States university focused on cellular telecommunications. In 1991, WINLAB was designated the National Science Foundation Industry/University Cooperative Research Center for Wireless Information Networks. I was the Director of WINLAB until 1999, when I joined Polytechnic University.

From 1967 to 1988, I was at Bell Laboratories, where I held the position of Department Head in Communications Systems Research. In 1995, I was a Research Associate at the Program on Information Resources Policy at Harvard University. In 1997, I was Chairman of the National Research Council Committee studying "The Evolution of Untethered Communications."

I have extensive experience performing and managing research in telecommunications and digital signal processing. My research in cellular telecommunications has produced innovations covering multiple access protocols, network architecture, mobility management, and radio resources management. In 1986 and 1987, while I was employed by AT&T Bell Laboratories, I had a research assignment in the United Kingdom. As part of this assignment, I had detailed technical discussions with experts in several European countries who were participating in the establishment of the GSM cellular standard. At that time, I acquired a thorough understanding of GSM technology, and I have maintained this expertise ever since through technical discussions, participation in various forums, and in the conduct of my teaching, research, and writing.

I was one of the first professors to teach a college-level course in cellular telecommunications and have taught such courses since January 1989. In the early 1990's, I also presented a three-day short course at many large companies including Bell Atlantic Mobile, Pacific Bell, US West, Ericsson and AT&T. This course introduced corporate students to the operations of several cellular systems including AMPS, TDMA, and GSM. I have lectured and published widely on the subject of cellular telecommunications. My publications include approximately 100 papers. I have also consulted for many corporations in this field, including: Ericsson, Motorola, Lucent Technologies, and Nortel Networks.

I received a Bachelor's degree at Rensselaer Polytechnic Institute in 1960, a Master's degree at New York University in 1962, and a Ph.D. at Imperial College, University of London in 1967, all in electrical engineering.

I am a Member of the National Academy of Engineering, a Foreign Member of The Royal Academy of Engineering, a Fellow of the Institute of Electrical and Electronics Engineers, and a Fellow of the Institution of Electrical Engineers.

In 1997, I received the ACM/SIGMOBILE Award for "Outstanding Contributions to Research on Mobility of Systems Users, Data, and Computing." In 1999, I won the RCR Gold Award for the best presentation at the Conference on Third Generation Wireless Communications. In 2003, I received an IEEE Avant Garde Award for Contributions to Speech Coding and Internet-Packet Cellular Networks. Three of my papers on wireless communications have been cited as Paper of the Year by IEEE journals.

I am a frequent public speaker in a variety of forums on wireless communications. I am author of the books *Wireless Personal Communications Systems*, published in 1997 by Addison Wesley and co-author, with Roy Yates, of *Probability and Stochastic Processes A Friendly Introduction for Electrical and Computer Engineers, Second Edition*, published in 2004 by Wiley. I am co-editor of six other books on wireless communications. I am a named inventor on eight United States patents and have one patent application pending.

B. List of Authored Publications

Attached as Exhibit A to my report is my Curriculum Vitae, which contains a list of publications that I have authored since 1988.

C. Prior Testimony

In the past four years I have provided expert testimony in depositions in the following cases: Aerotel, Ltd. v. Verizon Communications Inc. et al. (S.D.N.Y); PowerOasis, Inc. and PowerOasis Networks, LLC, v. T-Mobile USA, Inc., (D. NH); Papyrus Technology Corp. v. New York Stock Exchange, Inc., (S.D.NY); Agere v. Broadcom, (E.D. PA); and Freedom Wireless, Inc. v. Boston Communications Group, Inc. et al. (D. MA). In addition I testified at a Markman hearing and in a tutorial for the Court in Agere v. Broadcom, (E.D. PA).

D. INFORMATION RELIED ON

Attached as Exhibit B is a list of the materials that I reviewed in connection with my preparation of this report.

III. OPINIONS AND BASES FOR THOSE OPINIONS

A. LEGAL STANDARDS

In conducting my analysis and forming my opinions I have received and relied upon information provided by counsel regarding the applicable legal standards on patent invalidity.

I understand that issued U.S. Patents are presumed valid and that the standard to prove invalidity is clear and convincing evidence.

I understand that for an independent patent claim to be anticipated by the prior art, the prior art reference must disclose each and every limitation of the claim either expressly or inherently. I also understand for a dependent claim to be anticipated by the prior art, the prior art reference must disclose each and every limitation of both the dependent claim and any claim(s) from which it depends.

I understand that for a patent claim to be invalid for obviousness the differences between the claimed invention as a whole and the prior art would have been obvious to a person of ordinary skill in the art at the time of the invention. I understand that before an obviousness determination can be made, I must consider the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the claimed invention and the prior art.

I understand that claims are construed according to their plain and ordinary meaning to one of ordinary skill in the art. I understand that the same claim construction must be used for both an infringement analysis and an invalidity analysis; I understand that claims cannot be construed one way for an infringement analysis and a different way for an invalidity analysis.

I also understand that the Court has not yet construed claim terms in this case, but that the parties have exchanged various preliminary claim interpretations. Regardless of which

constructions are adopted it is my opinion that the Kono application will anticipate the '144 patent if its claims are read broadly enough to cover Andrew's Geometrix products.

B. ORDINARY SKILL IN THE ART

A person of ordinary skill in the art of the '144 patent would have had a masters degree in electrical and computer engineering or computer science, or the equivalent skills and knowledge, and/or at least two years' experience at a cellular operating company, or a company that designs/produces cellular systems or services, including value added systems or services such as location determination.

C. THE '144 PATENT

The '144 patent is titled "Cellular Telephone Location System". Using the system disclosed in the patent, an AMPS cellular telephone network estimates the geographical coordinates of cellular telephones served by the network.

The technique at the heart of the purported invention is referred to as Time Difference of Arrival (TDOA) location determination. TDOA location determination was a well known technique at the time of the invention.

To use this technique in a cellular network, the patent dictates that at least three cell sites must receive the same radio signal from a cellular telephone. Each one converts the radio signal to a baseband signal, digitizes the base band signal and sends the digitized baseband signal, along with a time stamp to a central site. As shown in Figure 7 of the '144 patent, the central site uses correlation techniques to estimate the differences among times of arrival ("TDOA data") at all pairs of reporting cell sites. It uses the TDOA data to estimate the geographical coordinates of the cellphone by comparing the measured delays with a grid of reference delays stored at the central site. Each reference delay is associated with a unique geographical reference location. The central site uses a least squares metric to determine the best reference location. After determining the best reference location, the central site again uses a least squares technique to further refine the location estimate.

All of the claims of the '144 patent pertain to cellular telephone systems. Figures 1A and 1C of the '144 patent display some of the properties of a generic cellular system. Figure 1C

shows "the main components and arrangement of cellular telephone system." '144 Pat., Col. 1, ll. 51-52.

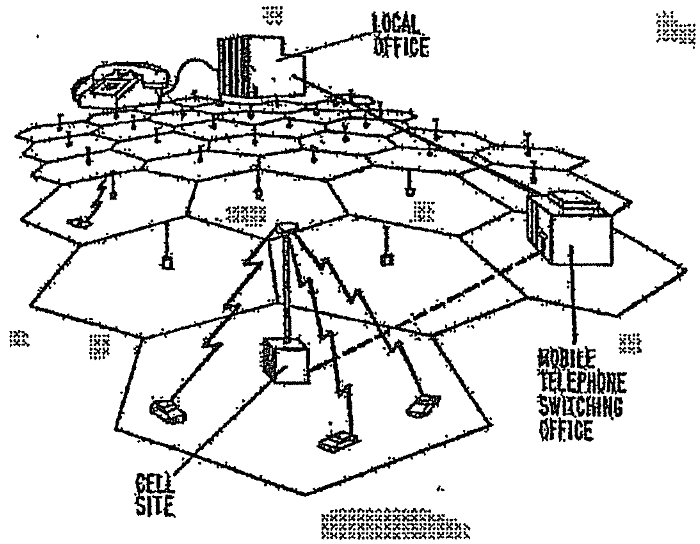


Fig. 1C, '144 Patent

Figure 2 of the '144 patent shows "a schematic diagram of a cellular telephone location system in accordance with the present invention." '144 Patent, Col. 7, ll. 60-62.

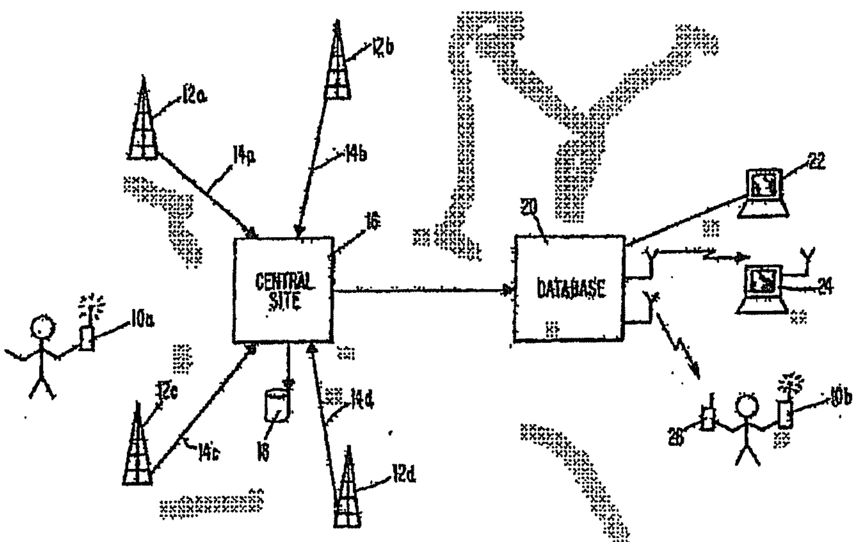


Fig. 2, '144 Patent

D. CLAIM TERMS

A person of ordinary skill in the art would recognize that the terms of art in the '144 patent were used to describe analog cellular systems in common use when the patent was filed in 1993.

(1) Analog Systems and Reverse Control Channels

In all of the patent claims, the first important limitation is "cellular telephones each initiating periodic signal transmissions over one of a prescribed set of reverse control channels". A person of ordinary skill in the art in 1993 would recognize reverse control channels as components of the analog cellular and dual-mode telephone systems specified in the United States national standard, ANSI 553, in Interim Standard 54, and Interim Standard 95 published by the Telecommunications Industry Association.

My interpretation is further supported by the following passage of the '144 patent, and the testimony of two named inventors regarding that passage. The '144 patent states:

> In addition, it should be noted that the inventive concepts disclosed herein are applicable to both analog and digital (for example, TDMA) cellular systems that employ analog control channels.

'144 patent, col. 1, lns. 27-31. A person of skill in the art would recognize "digital ... systems that employ analog control channels" to refer to cellular systems that carry voice information in a digital format and use the signal formats of the AMPS system for transmitting system control information.

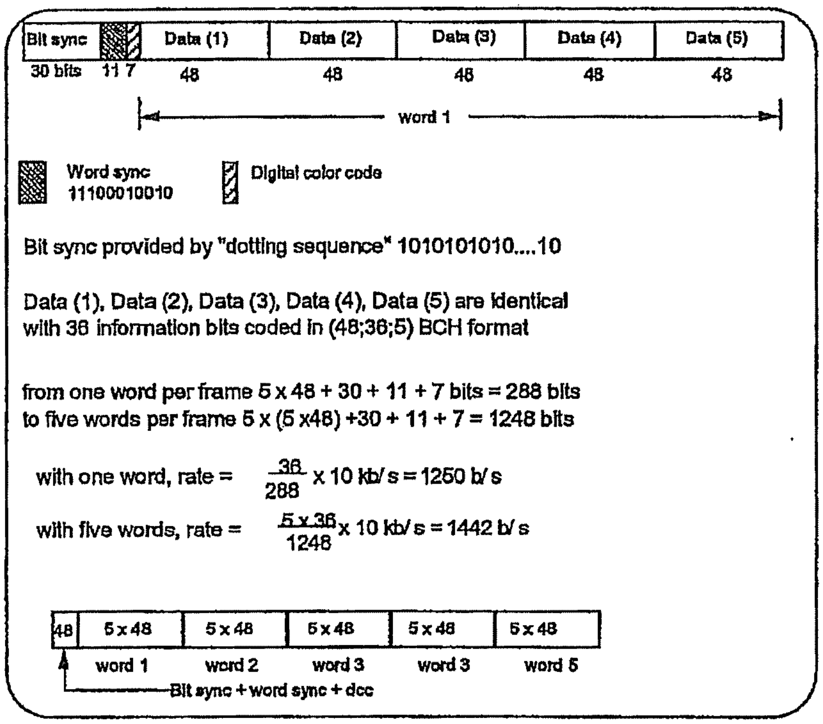
Named inventor Dr. Curtis Knight testified:

Q: What are analog control channels?

A: I'm not sure I know what was meant by that but what we had in mind was AMPS when we were writing this.

Knight October 6, 2006 Page 89 at 25 through Page 90 at 13. Named inventor Dr. John Webber concurred. Webber October 4, 2006 Page 23 at 9-18.

There are two types of transmissions disclosed in the '144 patent; one type is a signal transmitted over a "reverse control channel." The analog cellular standards that use the term "reverse control channel" specify that cellular telephones transmit information in a prescribed format that is different than the format specified by GSM. The format specified by analog cellular standards is illustrated in the following diagram that I prepared many years ago to explain the AMPS system to students:



<u>**Fig. 3.10, Wireless Personal Communications Systems**</u>

"Reverse control channels" also have a many-to-one property in that they convey information from many cellular phones to one base station.

In order to assert the '144 patent against cellular systems that use Andrew technology, True Position has to adopt an interpretation of "transmissions over ... reverse control channels" that is significantly more inclusive than the transmissions addressed by the '144 patent. This

inclusion would embrace a wider range of signal formats carried on channels that convey information from many cellular telephones to one base station.

(2) The Independent Claims

The independent claims (1, 22, and 31) asserted by True Position address details of: (a) the signal transmitted by a cellphone; (b) signal reception at the cellular cell sites; (c) the way in which the arrival time is determined at each cell site; (d) the nature of the reports transmitted by the cell sites to the location determination device; and (e) how the location determination device uses the reports to calculate the geographical coordinates of the cellphone.

a. Signals transmitted by a cellphone

The independent claims state that the signals used for location determination are transmitted periodically "over one of a prescribed set of reverse control channels".

b. Signal reception at the cell sites

Claim 1 requires that the signal reception be accomplished by an antenna and a baseband converter coupled to the antenna. In Claim 22, the cell sites are equipped to receive the signals from the cellphone and Claim 31 states that the location determination method receives the signals.

c. Determining arrival time at cell sites

Claim 1 requires a timing signal receiver for receiving a timing signal common to all cell sites.

d. Reports transmitted by the cell sites

Claim 1 requires that the baseband signal be sampled at a prescribed frequency and that the signal samples and a time stamp be formatted in digital data frames with a prescribed number of data bits. Claim 31 requires the cell site to produce frames of data with a prescribed number of data bits and time stamp bits.

e. Using the reports to calculate cellphone location

Claim 1 requires that the reports arrive at a central site system from the cell sites. The central site system processes the frames of data in the report to produce a table identifying individual signals and associated time differences of arrival at the cell sites. It then determines cellphone locations from the time differences of arrival. Claim 22 requires the system to have a database, accessible from remote locations, containing cellphone identities and locations. Claim 31 states that the system processes the frames of data from the cell sites to identify cellular telephones and differences in times of arrival and that it uses this information to determine cellphone location.

E. The Kono Application

The title of the Kono application is translated to English as "Moving Body Radio Communication Apparatus". Like the '144 patent, it describes determination of the location of a cellular telephone from information about the arrival times at a plurality of base stations of a position locating signal transmitted by the telephone.

The Kono application states that the signal is transmitted on a shared channel and received at multiple base stations. Each base station determines the time of arrival of the position locating signal and transmits associated data to a switching station that in turn transmits the data to a position location calculating device. This device uses data from the base stations such as time differences of arrival at the multiple base stations to calculate the position of the cellphone.

F. Relation of the '144 Patent to the Kono Application

All of the claims of the '144 patent pertain to cellular telephone systems. As discussed above, Figure 2 of the '144 patent shows a "a schematic diagram of a cellular telephone location system in accordance with the present invention"; similarly, the Kono application places the invention in the context of a generic cellular system illustrated in Figures 1 and 4:

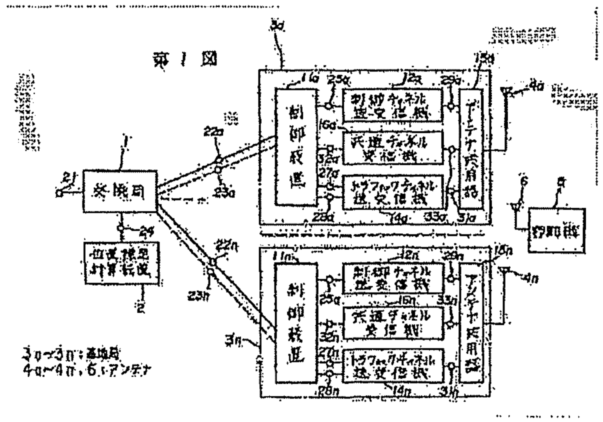


Fig. 1, Kono Application

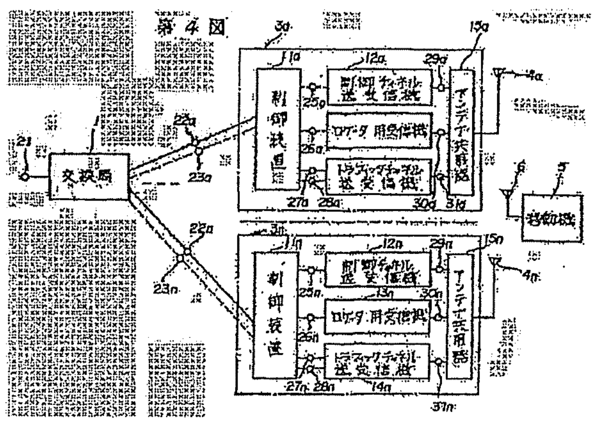


Fig. 4, Kono Application

Within this system, all of the claims of the '144 patent require periodic transmissions by the cellular telephones over reverse control channels. The Kono application describes "position locating signals from a moving body using shared channels" (page 3, 4th paragraph). It is clear that "moving body" in the Kono application is synonymous with the cellular telephone in the '144 patent.

All of the '144 patent claims require three or more cell site systems that receive the periodic transmissions from the cellular telephones. Similarly the Kono patent refers to *n* base stations (labeled *3a* to *3n* in Figures 1, 3, and 4, each containing a shared channel receiver (*16a* – *16n*).

Claim 1 of the '144 patent requires "an elevated ground-based antenna" at each cell site. Figures 1, 3, and 4 of the Kono application also display antennas (labeled *4a* – *4n*) at the *n* base stations.

Claim 1 of the '144 patent also includes a "baseband converter" for receiving the periodic transmissions on the reverse control channels. The corresponding device in the Kono application is a shared channel receiver at each base station (***16a* – *16n***).

The cell site system in Claim 1 of the '144 patent also includes a "timing signal receiver for receiving a timing signal common to all base stations". The corresponding device in the Kono application is an ultra-high precision clock (labeled *54* in Figure 2) within each of the shared channel receivers. The ultra-high precision clocks at all of the base stations are "corrected by the switching station *1*". Page 5, ¶ 3, l. 16.

The other element of the cell site system in Claim 1 of the '144 patent is a "sampling subsystem" that samples the baseband signal and formats the samples and time stamps in frames of digital data. Each time stamp represents the time of arrival of one locating signal from a cellphone. In the Kono application, the base stations *3a* – *3n* receive the position locating signal. A time measurement circuit (*53*) in each base station measures the absolute time of arrival and reports it to the switching station. A person of ordinary skill in the art would recognize that the report would be contained in data frames.

Part (b) of Claim 1 of the '144 patent specifies a "central site system operatively coupled to said cell site systems". The corresponding element of the Kono application is the switching station (*1*) in communication with the base stations (*3a – 3n*) through junction points (*23a – 23n*) that convey data or control signals between the switching system and the base stations.

The central site system in Claim 1 of the '144 patent processes the frames of data arriving from the cell site systems and generates a table containing information that identifies the signals arriving from the cell sites and time differences of arrival at the different cell sites. The central site system contains a "means for determining, on the basis of said times of arrival differences, the locations of the cellular telephones." In the Kono application the switching station "receives data in the form of these position locating signals" forwards the data received from the base stations to the position locating device (*2*). The position locating device uses the data to calculate the position of the cellular telephone.

Claim 2 of the '144 patent depends on Claim 1 and states that the timing signal receiver is a Global Position System receiver. In the Kono patent the timing signal common to all base stations exists at the switching station (*1*): "...the time of the standard clock *54* is corrected by the switching station *1*." Page 5, ¶ 3, l. 16. Since at least as early as 1993, some cellular networks have had GPS receivers at every base station. The GPS receivers receive a timing signal common to all base stations. The location systems disclosed in the Kono reference work in conjunction with cellular networks. When those cellular networks have GPS receivers, they can be used with the location system disclosed.

Claim 22 of the '144 patent is less specific than Claim 1. In addition to base stations and reverse control channels Claim 22 requires simply a means of determining the locations of the cellular telephones "by receiving and processing signals emitted during said periodic reverse control channel transmissions". The elements of the Kono application that perform this function are the shared channel receivers in the base stations, the ultra-high precision clocks, the time measurement circuit, the switching station and the position locating device.

The remainder of Claim 22 specifies a "database means for storing location data identifying the cellular telephones and their respective locations, and for providing access to said database to subscribers at remote locations". Since their inception in the early 1990s, GSM

networks have had Home Location Registers ("HLRs") and Visitor Location Registers ("VLRs"). Because Andrew's products do not have a database, if TruePosition argues for an interpretation of "database means" that is broad enough to encompass Andrew's products, this element is anticipated by the HLR and VLR inherent in the cellular systems taught by the Kono application.

Claim 31 describes the same operations as Claim 1 without referring to the antenna, the baseband converter, the timing signal receiver, and the sampling subsystem at each cell site. It requires frames of data that are processed to identify individual telephones and time differences of arrival and using the time differences to determine the locations of the cellular telephones. The corresponding operations in the Kono application are described above in the comparison of Claim 1 of the '144 patent with the Kono application.

Claim 32 depends on Claim 31. It is identical to the final Claim element of Claim 22.

(1) Summary Chart Reflecting Opinions

Claim Language	Present In Kono?	Kono Disclosure
1. A cellular telephone location system for determining the locations of multiple mobile cellular telephones	Yes	"FIG. 1 shows a configuration of a moving body position locating apparatus" Page 3 ¶ 6, ll. 12.
each initiating periodic signal transmission over one of a prescribed set of reverse control channels, comprising:	Yes	"a moving body transmits position locating signals using shared channels" Page 3 ¶ 5, l. 1.
(a) at least three cell site systems, each cell site system comprising:	Yes	Base stations 3a-3n.
an elevated ground-based antenna;	Yes	Antennas 4a-4n.
a baseband convertor operatively coupled to said antenna for receiving cellular telephone signals transmitted over a reverse control channel by said cellular telephones and	Yes	~~Control~~ channel transceivers ~~12a-12n~~ Shored 16a-16n.

Claim Language	Present In Kono	Kono Disclosure
providing baseband signals derived from the cellular telephone signals;		
a timing signal receiver for receiving a timing signal common to all cell sites;	Yes	"...the time of the standard clock *54* is corrected by the switching station *1*." Page 5, ¶ 3, l. 16.
and a sampling subsystem operatively coupled to said timing signal receiver and said baseband convertor for sampling said baseband signal at a prescribed sampling frequency and formatting the sample signal into frames of digital data, each frame comprising a prescribed number of data bits and time stamp bits, said time stamp bits representing the time at which said cellular telephone signals were received; and	Yes	Kono teaches software and processors in control circuit *55* that determine and format time of arrival information. Time stamp bits: "The standard clock *54* is an ultra-high precision clock, and the time measurement circuit *53* measures the absolute time of the above-mentioned trigger, and reports it to the switching station *1* from the control circuit *55* via the control device *11*." Page 5, ¶ 3. ll. 13-15. Data bits: "It should be noted that the junction points *22a – 22n* are used for voice communication signals, and the junction points *23a – 23n* are used for data or control signals." Page 5, ¶ 1, ll.15-17.
(b) a central site system operatively coupled to said cell site systems, comprising:	Yes	Switching station *1* and position location calculating device *2*.
means for processing said frames of data from said cell site systems	Yes	"The base station *1* forwards these data to the position location calculating device *2*, and the position of the mobile equipment *5* is calculated." Page 4, ¶ 2, ll.23-25.
to generate a table identifying individual cellular telephone signals and the differences in times of arrival of said cellular telephone signals among said cell site systems;	Yes	"reports to the switching station *1* via the control devices *11a – 11n* data such as the difference in arrival time of position locating signals with respect to the various base stations *3a – 3n*." Page 4, ¶ 2, ll. 21-23.
and means for determining, on the basis of said times of arrival differences, the locations of the cellular telephones responsible for said cellular telephone signals.	Yes	"The base station *1* forwards these data to the position location calculating device *2*, and the position of the mobile equipment *5* is calculated." Page 4, ¶ 2, ll. 23-25.

Claim Language	Present In Kono	Kono Disclosure
2. A cellular telephone location system as recited in claim 1,	Yes	See the above claim chart for claim 1.
wherein said timing signal receiver comprises a global positioning system (GPS) receiver.	Yes	Since at least as early as 1993, some cellular networks have had GPS receivers at every base station. The location systems disclosed in the Kono reference and the '144 patent work in conjunction with cellular networks. When those cellular networks have GPS receivers, they can be used by the location system.

Claim Language	Present In Kono	Kono Disclosure
22. A ground-based cellular telephone system serving a plurality of subscribers possessing mobile cellular telephones, comprising:	Yes	"FIG. 1 shows a configuration of a moving body position locating apparatus" Page 3 ¶ 6, ll. 12.
(a) at least three cell sites;	Yes	Base stations 3a-3n.
equipped to receive signals sent by multiple mobile cellular telephones	Yes	~~Control~~ shared channel transceivers ~~*13a-13n*~~ 16a-16n
each initiating periodic signal transmissions	Yes	"a moving body transmits position locating signals using shared channels" Page 3 ¶ 5, l. 1.
over one of a prescribed set of reverse control channels	Yes	"~~*13a*~~ 16a – ~~*12n*~~ 16n are ~~[illegible]~~ shared channel transceivers that transmit and receive signals for the control channels allotted for each of the base stations *3a – 3n.*" Page 2, ¶ 2, ll. 5-6.
(b) locating means for automatically determining the locations of said cellular telephones by receiving and processing signals emitted during said periodic reverse control channel transmissions; and	Yes	Kono teaches software and processors in control unit *55* that determine and format time of arrival information. "The standard clock *54* is an ultra-high precision clock, and the time measurement circuit *53* measures the absolute time of the above-mentioned trigger, and reports it to the switching station *1* from the control circuit *55* via the control device *11.*" Page 5, ¶ 3, ll. 13-15. "The base station *1* forwards these data to the position location calculating device *2*, and the position of the mobile equipment *5* is calculated." Page 4, ¶ 2, ll. 23-25.

(c) database means for storing location data identifying the cellular telephones and their respective locations, and for providing access to said database to subscribers at remote locations.	Yes	Since their inception in the early 1990s, GSM networks have had Home Location Registers ("HLRs") and Visitor Location Registers ("VLRs"). Because Andrew's products do not have a database, if TruePosition argues for an interpretation of "database means" that is broad enough to encompass Andrew's products, this element is anticipated by the HLR and VLR inherent in the cellular systems taught by the Kono application.

Claim Language	Present In Kono?	Kono Disclosure
31. A method for determining the location(s) of one or more cellular telephones	Yes	"FIG. 1 shows a configuration of a moving body position locating apparatus" Page 3 ¶ 6, ll. 12.
each initiating periodic signal transmissions over one of a prescribed set of reverse control channels, comprising the steps of:	Yes	"a moving body transmits position locating signals using shared channels" Page 3 ¶ 5, l. 1. 16a – 16n shared
(a) receiving said reverse control channel signals at least three geographically separated cell sites;	Yes	"~~23a~~ – ~~23n~~ are ~~control~~ channel transceivers that transmit and receive signals for the control channels allotted for each of the base stations *3a – 3n.*" Page 2, ¶ 2, ll. 5-6.
(b) processing said signals at each cell site to produce frames of data, each frame comprising a prescribed number of data bits and time stamp bits, said time stamp bits representing the time at which said frames were produced at each cell site;	Yes	Kono teaches software and processors in hardware unit 55 that determine and format time of arrival information. Time stamp bits: "The standard clock *54* is an ultra-high precision clock, and the time measurement circuit *53* measures the absolute time of the above-mentioned trigger, and reports it to the switching station *1* from the control circuit *55* via the control device *11.*" Page 5, ¶ 3. ll. 13-15. Data bits: "It should be noted that the junction points *22a – 22n* are used for voice communication signals, and the junction points *23a – 23n* are used for data or control signals." Page 5, ¶ 1, ll.15-17.

(c) processing said frames of data to identify individual cellular telephone signals and the differences in times of arrival of said cellular telephone signals among said cell sites; and	Yes	"reports to the switching station *1* via the control devices *11a – 11n* data such as the difference in arrival time of position locating signals with respect to the various base stations *3a – 3n*." Page 4, ¶ 2, ll. 21-23.
determining, on the basis of said times of arrival differences, the locations of the cellular telephones responsible for said cellular telephone signals.	Yes	"The base station *1* forwards these data to the position location calculating device *2*, and the position of the mobile equipment *5* is calculated." Page 4, ¶ 2, ll. 23-25.

Claim Language	Present in Kono?	Kono Disclosure
32. A method as recited in claim 31,	Yes	See the above claim chart for claim 31.
further comprising the steps of storing, in a database, location data identifying the cellular telephones and their respective locations, and providing access to said database to subscribers at remote locations.	Yes	Since their inception in the early 1990s, GSM networks have had Home Location Registers ("HLRs") and Visitor Location Registers ("VLRs"). Because Andrew's products do not have a database, if TruePosition argues for an interpretation of "database means" that is broad enough to encompass Andrew's products, this element is anticipated by the HLR and VLR inherent in the cellular systems taught by the Kono application.

IV. RESERVATION OF RIGHTS

This report presents my opinions to date regarding the matters set forth above. As additional data, information, or testimony becomes available to me or is provided to me, I intend to consider this information. I thus reserve the right to modify or supplement this report or the opinions contained herein if I find it appropriate to do so in light of any additional information. I may also be called upon to, and intend to if asked, provide expert testimony in rebuttal to any proofs put forth by TruePosition or any opinions expressed in expert reports on behalf of TruePosition.

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Dated: December 1, 2006

David J Goodman

Dr. David J. Goodman